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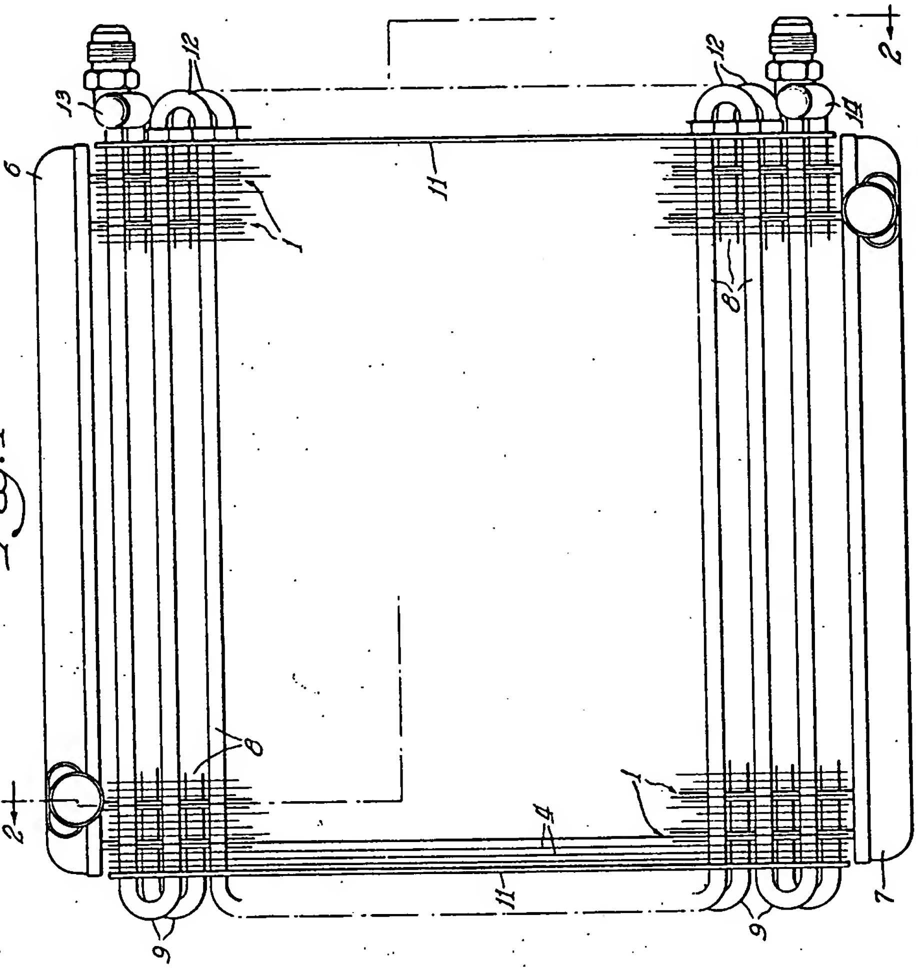

Fig. 1

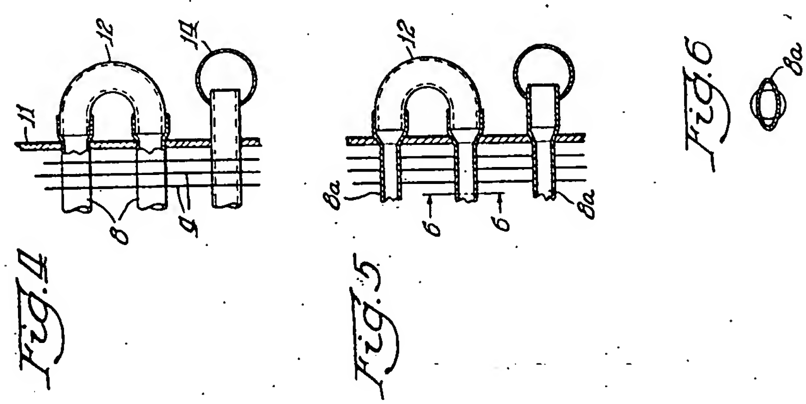

Fig. 4

Fig. 5

Fig. 6

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Fig. 3

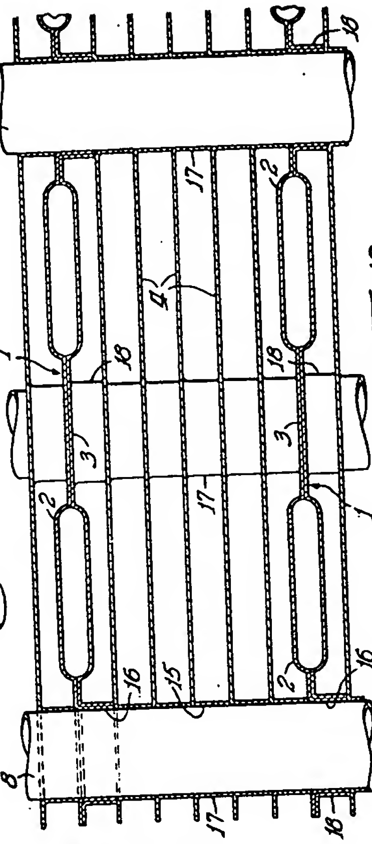

Fig. 12

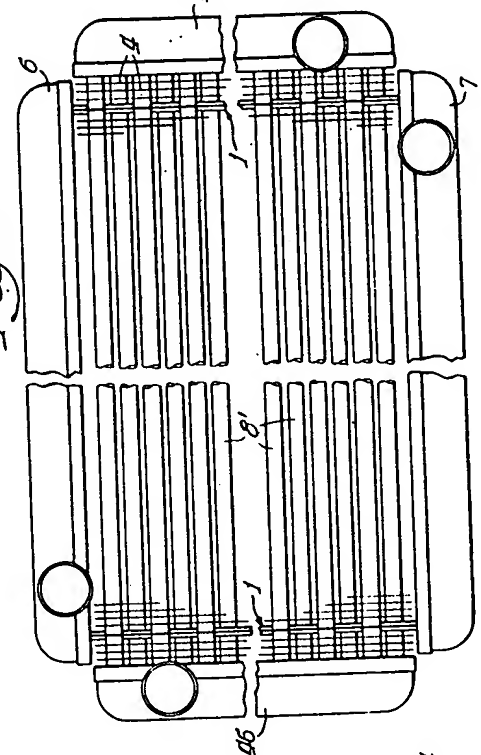

Fig. 2

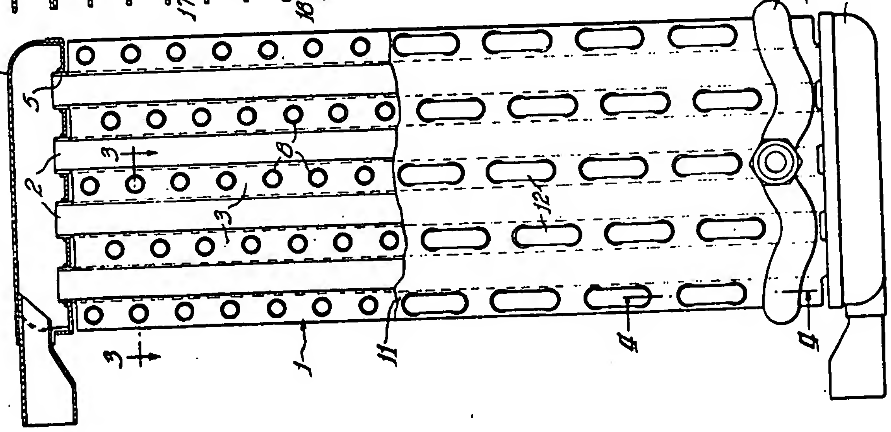

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Fig. 7

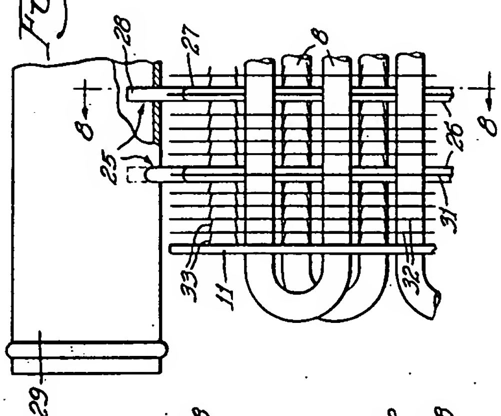


Fig. 8

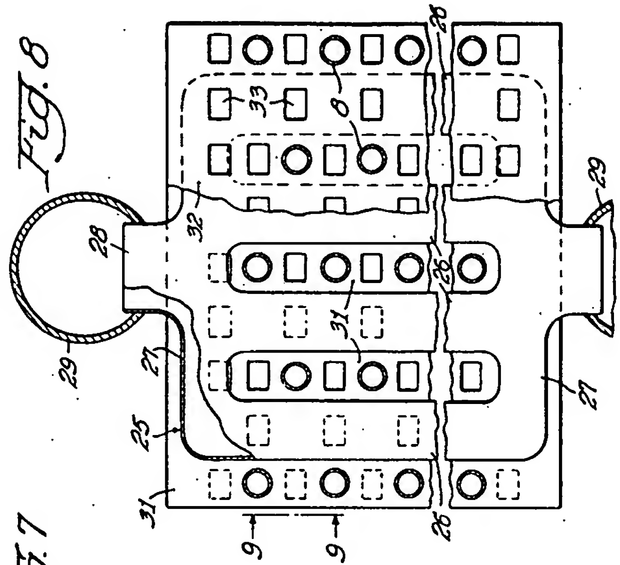


Fig. 9

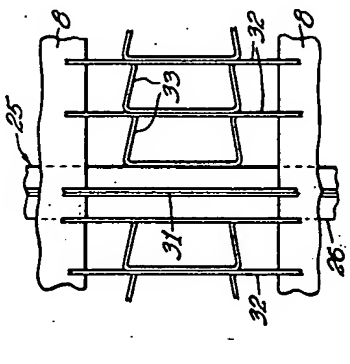


Fig. 10

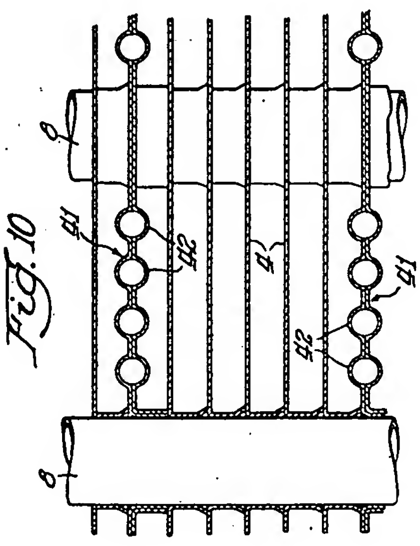
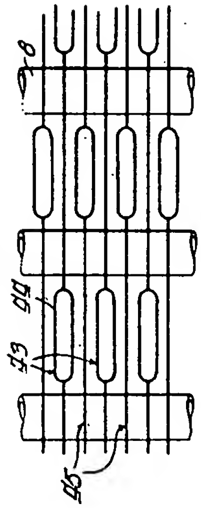


Fig. 11



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Multiple Purpose Heat Exchange Coil

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Application May 21, 1957, Serial No. 729,546

In the United States May 25, 1956

14 Claims

This invention relates to heat exchangers, and more particularly to multiple purpose heat exchange coils.

Heat exchange units in a wide variety of designs today serve many varied purposes, and each particular design in order to provide maximum functional purpose takes into account all factors that are in part of the particular application in mind. These factors represent proper arrangement of heat transfer surfaces which in turn include circuits or conducting means for the heat carrying agents, be it a gas or liquid, and careful consideration to economical manufacturing processing.

The field for heat exchange units, which includes coils of the type to which this application has particular reference, is extremely broad and far reaching. Though we do not intend to limit the broad application of basic principles here disclosed, our immediate concern is with its application to air-conditioning units or assemblies for passenger cars, truck, bus, railway, home or industrial uses.

The accepted practice today is to use a heat transfer coil for a single purpose either as an acceptor or a dissipator of heat, and the circuits for carrying the liquids or gases, with communicating heat transfer surfaces, are proportioned accordingly.

Our invention provides a heat exchange device which is both economical and efficient and so constructed as to provide ready access to the heat exchange circuits, and as disclosed in its preferred form herein comprises a multiple purpose heat exchange coil with two distinctly separate circuits for conducting the heat exchange agents, these circuits being usable simultaneously or alternately. Extended or secondary heat transfer surfaces are supplied which are common to both circuits. In many cases, a single circuit will be used at one time, and in which case the prime surface of the circuit which is not in use will serve as an additional secondary surface for the circuit in use. The medium for accepting or dissipating heat may be air or some other gaseous or liquid medium which would be circulated externally between fins, which constitute part of the secondary surface. The design of the coil of the present invention permits the use of its heat exchange surfaces for a wide variety of purposes including both heating and cooling, the multiple circuits being used either singly or simultaneously.

Contrary to the teaching of the prior art which suggests two circuits in parallel relationship, the circuits of the coils of the present invention are at right angles to each other. This results in the advantageous possibility of manifolding on the four sides of the coil, and results in placing all the metal joints in the open where they are accessible for leak checking and, when necessary, ready repair. This is vitally important from the standpoint of good production practice as well as controllable field servicing. In addition, the particular relationship between the the two circuits is such as to provide a compact structure, but one which nevertheless permits intimate contact with the heat accepting or dissipating external fluid and the ready flow of such external fluid through the unit.

This construction also lends itself to the ready use of a variety of basic materials such as copper, aluminum, steel or any of their alloys, or a combination of any of these materials. In addition, substantially any shape of circuit tubing may be employed.

It is therefore one object of the present invention to provide a new and improved multiple purpose heat exchange coil which is economical, efficient, compact and readily serviceable.

Another object is the provision of a device in accordance with the preceding object which includes two fluid circuits at right angles to each other.

Another object is the provision of a device in accordance with the preceding objects in which the members forming one of the fluid circuits extend through members forming the other fluid circuit and in intimate heat conducting relation therewith.

Another object is the provision of a device in accordance with the preceding objects in which the manifolding may be accomplished at any of the four sides of the coil.

Another object is the provision of a device in accordance with the preceding objects in which the circuit defining members are disposed at right angles to each other with one of the circuit defining members extending through the other circuit defining member in heat conducting relation therewith, and in which secondary heat conducting surfaces are disposed in engagement with one or both of the circuit defining members.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawings illustrating certain preferred embodiments in which:

Figure 1 is a front elevational view of a heat exchanger constructed in accordance with the principles of present invention;

Figure 2 is a sectional view along the plane of line 2—2 of Figure 1;

Figure 3 is an enlarged sectional view along the plane of line 3—3 of Figure 2;

Figure 4 is an enlarged sectional view along the plane of line 4—4 of Figure 2;

Figure 5 is a view similar to Figure 4 illustrating a modification of the structure shown in Figure 4;

Figure 6 is a sectional view along the plane of line 6—6 of Figure 5;

Figure 7 is a partial front elevational view of a modified form of the invention;

Figure 8 is a sectional view along the plane of line 8—8 of Figure 7;

Figure 9 is an enlarged sectional view along the plane of 9—9 of Figure 8;

Figure 10 is a view similar to Figure 3 illustrating a modified construction;

Figure 11 is a view similar to Figure 10 illustrating a further modification;

Figure 12 is a view similar to Figure 1 illustrating another modified form of the present invention.

With reference to the form of the present invention illustrated in Figure 1, there is disclosed therein

means defining a first fluid circuit which comprises a plurality of vertically extending, laterally spaced tube sheets 1 of copper or other suitable heat conducting and fluid impervious material. These tube sheets may be of the type described in United States Letters Patent No. 2,759,247, issued to L. H. Grenell et al. on August 21, 1956, or other similar constructions. In any event, these tube sheets comprise an integral combination of tubing and tube-spacing sheet. As best illustrated in Figure 3, the tube sheets each comprise a plurality of integral tubes 2, each of which is separated from the other by a sheet 3 of the same material of which the tubing is formed. This is a widely known commercial product, and per se forms no part of the present invention. Disposed between each of the tube sheets 1 are a plurality of fin members 4 of relatively thin, heat conducting material which are parallel to tube sheets 1 and disposed in vertical position. The upper ends of each of the tubes 2, as best disclosed in Figure 2, respectively extend through suitable openings 5 in the under surface of an upper manifold 6, the tubes 2 being joined to the sides of the openings 5 in a pressure sealed relationship by soldering, brazing or other common method. Upper manifold 6 is, of course, a fluid tight enclosure adapted to retain the fluid to be supplied to the tubes 2 of the tube sheets 1. The lower ends of each of the tubes 2 are each disposed in fluid communication with the upper surface of a lower manifold 7 and extend therein through suitable apertures provided in the manifold 7 in fluid tight engagement with the sides of these apertures by soldering, brazing, or other common method, so as to form a closed fluid circuit extending from the upper manifold 6, through the tubes 2, and into the lower manifold 7.

Extending horizontally through the device of the present invention, as illustrated best in Figure 1, is a fluid circuit which is formed by a plurality of generally U-shaped tubular members 8, of fluid impervious, heat-conducting material. As best illustrated in Figure 1, the tubular members 8 have return bent portions 9 at their left ends, which project outwardly beyond a side wall 11 of the device; the right ends of members 8 project beyond the other side wall 11 and are provided with semi-circular return bends 12 which are attached to the open ends of members 8 by insertion into their extremities beyond the end supporting plates 11 and properly sealed by soldering or comparable methods, as best illustrated in Figure 4. The uppermost tubular members 8 are connected to an upper, fluid containing manifold 13 by having their ends extending therein in suitable fluid tight relation, and the lowermost tubular members 8 have their respective open ends extending into a lower manifold 14, also in fluid tight relation therewith by soldering or comparable methods, so that a closed fluid circuit exists from the upper manifold 13 through the tubular members 8 and out into the manifold 14 at the lower portions of the device.

As best illustrated in Figures 2 and 3, the tubular members 8 have horizontal central portions staggered vertically, and with particular relation to Figure 3 it is extremely important to notice that the central, horizontal portions of each of the tubular members 8 extend through suitable openings 15 and 16 respectively, provided in the fin members 4 and sheet portions 3 of tube sheets 1. The openings 15 and 16 are both formed by providing integral collars 17 and 18, respectively, in fin members 4 and sheet portions 3 which extend horizontally and which are shaped to be complementary to the exterior surface of the tubular members 8. These collars 17 and 18 are bonded to the tubular members 8 either mechanically by internal expanding or metallically by use of solder or other heat bonding medium to the end that the tube sheets and the fin members 4 are disposed in heat conducting relation with respect to each other and with respect to the tubular members 8. In addition, the collars 17 and 18 have a horizontal extent sufficient so as to engage the adjacent fin member or tube sheet to rigidify the assembly and provide uniform spacing of the tube sheets and fin members.

It will therefore be seen from the foregoing explanation of the construction that there are provided a pair of separated fluid circuits at right angles to each other, the first of which comprises the tubes 2 of the tube sheets 1 which extend in a vertical direction between the upper and lower manifolds 6 and 7, respectively, while the second fluid circuit comprises the tubular members 8 which have main portions extending in substantially a horizontal direction and provides a fluid circuit extending from the upper manifold 13 to the lower manifold 14. It will further be seen that heat transfer may occur from the tubes 2 of the tube sheets 1 to the tubular members 8 and to the fin members 4 and subsequently to or from the air or other fluid which flows through the device into the plane of Figure 1. Alternately, fluid may circulate through the tubular members 8 with heat transfer occurring from such tubular members through the fin members 4 and tube sheets 1 to or from the passing air.

In Figure 5 there is disclosed a construction employing generally oval-shaped tubular members 8a (similar to tubular members 8 except for such oval-shape) having rounded ends in sealed relation (by soldering or comparable methods) with the return bends 12 previously described. With such oval tubular members 8a, the openings 15 and 16 in the fin members 4 and the tube sheets 1, respectively, are also oval in shape so that the tube sheets and fin members are in mechanical and thermal conducting relation with the tubular members 8a.

Referring now to the embodiment of the present invention illustrated in Figures 7 through 9, there are illustrated therein a plurality of vertically extending and laterally spaced tube strips, designated in general by the numeral 25, preferably formed by the aforementioned "Roll-Bond" method or process. Each tube strip 25 comprises a plurality of spaced tubes 26 joined internally at their top and bottom portions by common conduit portions 27 which are respectively provided with an outwardly extending neck 28 which extends through a suitable opening in a manifold 29, it being understood that the neck 28 is in fluid tight relation (by soldering or comparable methods) with the cooperating openings in the manifold 29. The manifolds 29 may be of seamless tubing or a two-piece welded combination as desired to provide a fluid impervious chamber. Between each of the tubes 26 formed in the tube sheet 25 is an integral, flat section 31, similar to the section 3 previously described in connection with the tube strip 1 of Figure 1.

Disposed between each of the tube sheets 25 and extending in a vertical direction, parallel to the tube sheets are a plurality of fin members 32 of heat conducting material, these members being provided with integral formed extensions 33 adapted to engage the adjacent fin members 32 or the exterior walls of the cooperating tubes 26,

as best illustrated in Figure 9. These extensions 33 form the multiple purpose of supporting the tube conduits 26 against internal pressure, they provide additional heat conducting means and further effect self-spacing of the fin members 32. As discussed previously with respect to the embodiment of the present invention illustrated in Figures 1 through 6, tubular members 8 are provided having central portions which extend at substantially right angles with respect to the tube sheets 25 and the fin members 32. The horizontal portions of the tubular members 8 extend through complementary openings in the portions 31 of the tube sheets 25 and in the fin members 32, so that the tube sheets and fin members are in mechanical and heat conducting relation with the tubular members 8.

It will be seen with this construction which employs tube sheets 25 smaller external manifolds are employable; in addition, the rigidity of the structure is improved by virtue of the extensions 33 on the fin members 32.

Figures 10 and 11 respectively show various modifications of the present invention. In Figure 10 there is disclosed a construction generally similar to that illustrated in Figures 1 through 6, there being substituted for the tube sheets 1, however, tube sheets 41 which have a plurality of relatively small, circular tubes 42 formed therein as distinguished from the elongated, large tubes 2 of the tube sheet 1. Such a construction is desirable where conditions such as high internal pressures in the tubes 42 are to be employed. In Figure 11, the structure is also generally similar to that illustrated in Figures 1 through 6 but substitutes for the tube sheets 1, modified tube sheets 43 having tube sections 44 and sheet sections 45 integral therewith, the tube sections 44 being spaced more widely apart than the corresponding tube sections 2 of the tube sheets 1, previously described.

In Figure 12 there is described a further modification, which is generally similar to that illustrated in Figures 1 through 6, but in which the tubular members 8 are replaced by tubular members 8' which differ from the members 8 by having no return bend portions at their lateral ends. In distinction, the tubular members 8' are merely straight lengths of tubing, the opposite ends of which extend into and are in fluid tight relation with, respectively side manifolds 46 and 47, by soldering or other common methods. It will be obvious that with such a construction one of the fluid circuits is between the top and bottom manifolds 6 and 7 through the tube sheets 1, while the other fluid circuit extends laterally between the side manifolds 46 and 47 through the tubular members 8'.

It will thus be seen that in all of the embodiments of the present invention there are provided two independent fluid circuits in thermal and mechanical connection to each other, the fluid circuits extending at right angles to each other. This makes the device one of extreme compactness and yet provides accessibility to the necessary circuit connections at the ends of the circuit. In addition, it is very important to note that the construction is such that there are no manifold connections in the path of air flow through the device. In each of the embodiments, furthermore, fins are provided in parallel with one of the circuits and through which the other circuit extends in mechanical and heat conducting connection. It is obvious that when one of the circuits alone is employed to carry fluid, either for heating or cooling, the other circuit and the fins serves as a secondary circuit for heat transfer. In addition, both circuits may be used simultaneously and may carry either fluid of gaseous mediums as may be expedient in the particular application at hand.

Where the term "tube sheet" is employed herein it is intended to include the type of structure described marketed in the aforementioned United States Patent or of the type by Revere Copper and Brass Inc., under the trade mark "Tube-in-Strip" and described in the magazine Modern Metal of February, 1956; the similar product marketed by Reynolds Metals Co., known under the trade mark "Roll-Bond" process described in that issue of Modern Metals and also in the November 1954 issue of Modern Metals, or any other comparable or similar structure.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims:

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A heat exchange unit comprising a plurality of first tubes of thermally conducting material adapted to conduct fluid, thermally conducting means disposed between adjacent first tubes in thermal and mechanical connection therewith, a plurality of second tubes of thermally conducting material adapted to conduct fluid perpendicular to said first tubes extending through said thermally conducting means and in mechanical and thermal contact therewith, and manifold means in fluid communication with at least certain of said tubes.

2. A heat exchange unit comprising a plurality of first tubes of thermally conducting material adapted to conduct fluid, thermally conducting means disposed between adjacent first tubes in thermal and mechanical connection therewith, fin members of thermally conducting material extending generally parallel to said thermally conducting means; a plurality of second tubes of thermally conducting material adapted to conduct fluid extending through both said thermally conducting means and said fin members in mechanical and thermal contact therewith perpendicular to said tubes, said thermally conducting means and said fin members; and manifold means in fluid communication with at least certain of said tubes.

3. A heat exchange unit comprising a plurality of spaced tube sheets of thermally conducting and fluid impervious material, each of said tube sheets comprising an integral assembly of first tubes separated by tube spacing sections, a plurality of second tubes of thermally conducting material adapted to conduct fluid extending through said tube spacing sections and in mechanical and thermal contact therewith, and a plurality of manifold means respectively in fluid communication with at least certain of said first and second tubes.

4. A heat exchange unit comprising a plurality of spaced tube sheets of thermally conducting and fluid impervious material, each of said tube sheets comprising an integral assembly of first tubes separated by tube spacing sections, fin members of thermally conducting material extending generally parallel to said tube sheets, a plurality of second tubes of thermally conducting material adapted to conduct fluid extending through both said tube spacing sections and said fin members in mechanical and

thermal contact therewith, and a plurality of manifold means respectively in fluid communication with at least certain of said first and second tubes.

5. A heat exchange unit comprising a plurality of spaced tube sheets of thermally conducting and fluid impervious material, each of said tube sheets comprising an integral assembly of first tubes separated by tube spacing sections, a plurality of fin members of thermally conducting material extending generally parallel to said tube sheets, integral extension means formed on said fin members adapted to engage the adjacent fin member or tube sheet, a plurality of second tubes of thermally conducting material adapted to conduct fluid extending through both said tube spacing sections and said fin members in mechanical and thermal contact therewith, and a plurality of manifold means respectively in fluid communication with at least certain of said first and second tubes.

6. A heat exchange unit comprising a plurality of vertically extending tube sheets spaced laterally one from the other in a laterally aligned array, each of said tube sheets being formed of a thermally conducting and fluid impervious material forming an integral assembly of vertically extending first tubes separated by tube spacing sections, a plurality of second tubes spaced longitudinally within the unit including horizontally extending and vertically spaced portions, said second tubes being formed of a thermally conducting and fluid impervious material, said second tube portions extending through certain of said tube spacing sections of said tube sheets and in mechanical and thermal contact therewith, and a plurality of manifold means respectively in fluid communication with at least certain of said first and second tubes.

7. The device defined in Claim 6 in which each tube sheet includes integral internal conduits in fluid communication with each of the tubes therein.

8. The device defined in Claim 6 in which said second tubes comprise generally U-shaped parts having openings at the ends bridged by fluid-tight return bend members.

9. The device defined in Claim 6 in which said second tubes comprise lengths of substantially

straight parts, and in which said manifold means include manifolds at the opposite lateral sides of the unit in fluid communication with the opposite ends of said straight parts.

10. The device defined in Claim 6 in which vertically extending fin members of thermally conducting material are disposed between said tube sheets, and in which said horizontally extending portions of said second tubes extend through certain of said fin members and are in mechanical and thermal contact therewith.

11. The device defined in Claim 6 in which said tube sheets include integral aperture defining flanging shaped to conform to the exterior contour of said horizontally extending portions of said second tubes so as to be complementary thereto and effect the mechanical and thermal connection to said second tubes.

12. The device defined in Claim 10 in which said fin members and tube sheets include integral aperture defining flanging shaped to conform to the exterior contour of said horizontally extending portions of said second tubes so as to be complementary thereto and effect the mechanical and thermal connection to said second tubes.

13. The device defined in Claim 10 in which said fin members and tube sheets include integral aperture defining flanging shaped to conform to the exterior contour of said horizontally extending portions of said second tubes so as to be complementary thereto and effect the mechanical and thermal connection to said second tubes, and in which said flanging extends horizontally a sufficient distance to engage the adjacent tube sheet or fin member to rigidify the assembly and improve the thermal intercommunication between the elements of the unit.

14. The device defined in Claim 10 in which said fin members include integral extensions constructed and arranged to engage the adjacent fin member or tube sheet to rigidify the assembly and improve the thermal intercommunication between the elements of the unit.

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa, 1960